

DIRECTORATE FOR BIOLOGICAL SCIENCES (BIO)**\$970,230,000**
+\$152,490,000 / 18.6%**BIO Funding**
(Dollars in Millions)

	FY 2021			FY 2023 Request	Change over	
	FY 2021 Actual	ARP Actual	FY 2022 (TBD)		FY 2021 Actual Amount	Percent
Biological Infrastructure (DBI)	\$167.01	-	-	\$221.28	\$54.27	32.5%
Environmental Biology (DEB)	178.78	-	-	186.15	7.37	4.1%
Integrative Organismal Systems (IOS)	206.89	-	-	214.81	7.92	3.8%
Molecular and Cellular Biosciences (MCB)	155.55	-	-	162.47	6.92	4.4%
Emerging Frontiers (EF)	109.51	9.18	-	185.52	76.01	69.4%
Total	\$817.74	\$9.18	-	\$970.23	\$152.49	18.6%

About BIO

BIO supports fundamental research and infrastructure that promotes a unified understanding of life in all forms, from the biological molecules that are the machinery of living cells, to the populations of organisms and species that underpin the functioning of the Nation's ecosystems. In the past decade, biology has been transformed by new tools to describe and manipulate genomes, new means of simultaneously sensing processes at multiple biological scales, and new computational and AI approaches in bioinformatics and modeling that unveil the regulation of complex living systems. BIO seeks to capitalize on these advances to vastly improve our ability to understand life's deepest mysteries, and to enable new capabilities to modify organisms and ecosystems for societal benefit and economic prosperity. The progress that will drive the Nation's bioeconomy comes from discovering and harnessing life's evolutionary innovations. BIO's support for foundational and translational research promotes economic prosperity, health, security, and well-being by addressing existing and future global challenges.

BIO's scientific investments align directly with Administration priorities, including biotechnology to promote the bioeconomy, forecasting, and mitigating the impacts of global warming on essential ecosystem services, and predicting and preventing the emergence of infectious diseases. BIO investments in genomics; cellular, organismal, and developmental biology; and bioinformatics spur further development of capabilities in synthetic biology and enhance biotechnology beyond current state-of-the-art technologies. The accelerating power of this advanced biotechnology promises to sustain U.S. economic growth and innovation across multiple sectors including agriculture, biomanufacturing, pharmaceuticals, and other bioproducts.

Biotechnology advancements also support development of a circular bioeconomy that reduces carbon emissions and creates new sources of clean energy. To further support the development of dynamic, eco-forecasting models to predict climate change impacts at local, national, and global scales, BIO invests in research that covers the topics of ecology, evolution, and biodiversity, and includes support for the National Ecological Observatory Network (NEON). Similarly, BIO support for investigations into life's natural innovation will focus on understanding the adaptive potential of species and ecosystems to respond to climate change stressors such as ocean acidification, sea level rise, droughts, flooding, and other extreme events. Together, these investments are responsive to the national need to understand and develop solutions for the climate emergency. BIO will also increase

investments in research on infectious disease emergence and transmission, contribute to a goal of preventing future pandemics, and fill knowledge gaps concerning the spread and evolution of biothreats.

Biological questions often drive convergence research across multiple fields of science and technology and stimulate applications that enhance economic and national security, and societal well-being. Pursuits in the biological sciences to quantify living systems at all scales have propelled the frontiers of research in statistical, mathematical, and computer sciences to consider larger and more complex data sets that benefit from machine learning. Foundational research on microbes and their interactions with plants leverages these advances in data analytics using AI and advanced computing to fuel a revolution in agriculture. Similarly, collaborations between the biological and physical sciences have contributed to advances in biomaterial and other bio-inspired products, biological computing, and semiconductors, which exploit the extraordinary information density in genetic polymers, and neuro-technologies that power advances in neuroscience and cognition. Quantum biology, the application of quantum theory to biological systems, provides new insights into the power of photosynthesis for energy production as well as a fundamental understanding of vision, olfaction, magnetoreception, and other sensing systems. This research will enable bioinspired designs based on quantum energy production and sensing systems that will enhance American security.

Tackling bold questions in biology increasingly requires an integrated approach that leverages advances from multiple subdisciplines and incorporates cutting-edge methods, tools, and concepts. Such research is critical to inform solutions to societal challenges, including natural resource management, resilience to environmental change, and global food security. BIO investments in Integrative Biology (IntBIO) and in Biology Integration Institutes (BII) represent major funding opportunities to encourage this type of synergistic research seeking a holistic understanding of how living systems function. BIO will increase support for these two programs to accelerate discovery of underlying principles operating across all hierarchical levels of life, from cells to organisms to ecosystems. BII provides institute-scale funding to address integration within biology itself, integration of research across scales of living systems, and cultural integration across the traditional sub-disciplines of biology that will propel significant advances in the life sciences. BII and IntBIO awards promote this integrative biology through highly collaborative, team science endeavors, which also fosters diversity and inclusion in science. This complements BIO's other investments in workforce development, including postdoctoral fellowships, which will also be expanded to promote advanced training and integrative research on genomes, environment, and phenotypes.

BIO will place greater emphasis on racial equity and inclusion in the biological sciences with the goal of broadening participation of biologists across the nation through a comprehensive and integrated portfolio of programs. The portfolio implements three evidence-based strategies to support BIO's goals: targeting critical career transition points, investing in under-resourced institutions, and addressing the culture of science and its critical role in diversity, equity, and inclusion. In recognizing the importance of targeting critical career transition points, BIO is investing in new efforts to support full-time research, mentoring, networking, and training for recent college graduates through the Research and Mentoring for Postbaccalaureate in Biological Sciences program, with an emphasis on engaging underrepresented groups. BIO is also investing in new opportunities for mid-career scientists and researchers from groups underrepresented in STEM through the Mid-Career Advancement and Transitions to Excellence in Molecular and Cellular Biosciences (Transitions) programs, as well as its existing Postdoctoral Research Fellowships in Biology program to support a

diversity of young researchers, with an increased focus on broadening participation. For the strategy to invest in under-resourced institutions, BIO continues to invest in HBCU-EiR as well as a new program, Building Research Capacity of New Faculty in Biology, to enhance the research capacity and broaden the participation of new faculty of biology at predominantly undergraduate minority-serving institutions, as well as other universities and colleges that are not among the nation's most research-intensive institutions. For the strategy to address the culture of science and its crucial role in broadening participation, BIO will continue to leverage the unique ability of professional societies to create culture change in the biological sciences through the Professional Societies program as well as continue to invest in the cross-agency INCLUDES program. Finally, BIO will continue investments in the Research Experiences for Teachers Sites in Biological Sciences program to provide new opportunities to engage teachers and their classrooms in STEM and support early engagement and the creation of inclusive learning environments.

BIO promotes other opportunities for convergence research and training through active participation and foundational investments in several Big Ideas. BIO participates in the NNA Big Idea through investments in environmental research and observational infrastructure in the Arctic, the Long-Term Ecological Research program (LTER), and NEON. BIO also participates in QIS-related activities, contributing to more efficient and robust quantum technologies for solar energy harvesting, communication, and navigation, as well as cutting edge DNA-based quantum computing. BIO will support basic research in this area primarily through established research programs in MCB and research resource programs in DBI. BIO is making strategic investments in HDR from contributing to the mapping and understanding of the structure and function of tens of thousands of molecules in cells, to collecting and analyzing data from environmental observatories such as NEON, which provide open data on environmental and land use change for the entire United States. BIO's investments in data and informatics include CyVerse for omics data, Protein Data Bank for structural biology, and iDigBio for biodiversity collections. BIO also provides support for the Environmental Data Initiative and will continue to support a new Center for Open Environmental Data Synthesis to advance modeling and forecasting capability for climate change impacts established in FY 2022.

As the lead directorate, BIO is the steward of funds designated for NSF-wide investments for the URoL. For more information about the Big Ideas, see the narrative in the Cross Theme Topics section of the NSF-Wide Investments chapter.

BIO provides 65 percent of the federal funding for basic research at academic institutions in the life sciences.

Major Investments

BIO Major Investments (Dollars in Millions)

Area of Investment ^{1,2}	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over	
				FY 2021 Actual Amount	Percent
Advanced Manufacturing	\$7.16	-	\$17.16	\$10.00	139.7%
Artificial Intelligence	20.00	-	20.00	-	-
Biotechnology	110.00	-	130.00	20.00	18.2%
Climate: Clean Energy Technology	45.00	-	59.28	14.28	31.7%
Climate: USGCRP ³	155.00	-	237.15	82.15	53.0%
Improving Undergraduate STEM Education	5.00	-	5.00	-	-
Postdoctoral Research Fellowships in Biology ⁴	22.79	-	26.90	4.11	18.0%
Quantum Information Science	3.28	-	3.28	-	-
Understanding the Rules of Life	30.00	-	30.00	-	-

¹ Major investments may have funding overlap and thus should not be summed.

² This table reflects this directorate's support for selected areas of investment. In other directorate narratives, areas of investment displayed in this table may differ and thus should not be summed across narratives.

³ Funding includes resources for agency-wide initiatives.

⁴ \$10.50 million will support the Broadening Participation track.

- **Advanced Manufacturing:** BIO will support Advanced Manufacturing in collaboration with ENG, by supporting basic research, infrastructure, and standards in synthetic biology. BIO will also support the development of new tools and new platform organisms to advance biotechnology that will enable new biomanufacturing capabilities. BIO will continue support for an Industry-Academia-NSF partnership (the Engineering Biology Research Consortium) that provides leadership and training to a network of practitioners that will sustain and grow the U.S. bioeconomy.
- **AI:** BIO, together with other NSF directorates and offices, will increase support for artificial intelligence. BIO's AI investments occur primarily in DBI through the Advances in Biological Informatics program, and center-scale investments that advance computational capacity in bioinformatics. BIO will support an AI Institute to advance the use of AI methods such as machine learning, natural language processing, computer vision, and genetic algorithms in biological research. AI contributes to solving problems such as genome sequence alignment, prediction of protein structure, reconstructing evolutionary relationships, predicting species range distributions, and extracting quantitative information from multi-media data sources.
- **Biotechnology:** BIO will increase investments in support of the bioeconomy through research funding programs in synthetic biology, genomics, bioinformatics, biotechnology, and training fellowships to help build the U.S. workforce in this area. BIO will support research to advance the ability to build cells and cell-like systems, explore novel concepts and enabling technologies to develop next-generation information storage and computing systems driven by biological principles, foundational research, and tool development in the growing field of plant synthetic biology, and interdisciplinary research to develop novel biological platforms that are capable of sensing and responding to infectious agents and other biothreats. These investments will be coordinated with programs established in the Directorate for Technology, Innovation, and Partnerships (TIP) to translate knowledge and tools into applications that promote the U.S. bioeconomy in public health, agriculture, energy, climate change, and security.
- **Clean Energy:** BIO supports research to advance clean energy biotechnologies and practices

through fundamental research in areas such as systems and synthetic biology, plant genomics, and ecosystem sciences. This research seeks to streamline and scale the metabolic, energetic, and physiological potential of living organisms to produce non-petroleum sources of important chemicals/materials, plant biomass, feed stocks, and biofuels. Bioinspired design of complex biomaterials that can transform light into energy will also be supported. Investigations to assess the impact of fuel and/or bio-renewable chemical production on genome stability and phenotype of the production organisms are of interest, as are studies to assess environmental impacts of these technologies.

- **Climate Change:** With a broad set of complementary and interacting funding programs, BIO will increase its support for research to understand the critical feedbacks between Earth's biota and the climate system, and to advance predictive models for how climate warming will impact critical U.S. ecosystems, including agricultural systems, forests, grasslands, freshwater, coastal and arctic systems, human communities in both urban and rural regions, and Tribal Nations. In addition, BIO will increase support for research to understand the adaptive potential of species, ecosystems, and human society to respond to a warming climate and how this scales to impact regional ecosystems. Results will inform efforts to improve natural and human system resilience to climate change. BIO's support for this urgent challenge includes operations of NEON, the Nation's premier ecological observatory, and research programs such as LTER, Macrosystem Biology, and Dynamics of Integrated Socio-Environmental Systems. These provide the foundational knowledge to advance eco-forecasting capability and guide efforts to mitigate the impact of climate warming on human health, and sectors of the bioeconomy such as agriculture, fisheries, and forestry.
- **Improving Undergraduate STEM Education (IUSE):** BIO is committed to continuing investments to enhance and improve education in the nation. BIO supports the creation of networks of scientists, educators, and other stakeholders to advance and transform biology education. In pursuit of this goal, BIO will continue to support undergraduate biology education activities through Research Collaboration Networks in Undergraduate Biology Education to stay current with challenges, new technology, and trends. BIO places a high value on virtual learning, including virtual tutoring systems and virtual laboratories. For more information regarding IUSE, see the Cross Theme Topics section of the NSF-Wide Investments chapter.
- **Postdoctoral Research Fellowships in Biology:** BIO will continue to support this program with an increased emphasis on broadening the participation of groups underrepresented in biology. BIO's investments will prepare biologists from underrepresented groups and others who share NSF's diversity goals at the postdoctoral level for scientific leadership positions in academia, industry, and government.
- **QIS:** BIO will continue to support QIS through investments in fundamental research in biophysics that seek to understand quantum phenomena within living systems and can inform applications in quantum information science.
- **URoL:** BIO will provide stewardship support for the NSF URoL Big Idea, which emphasizes multi-disciplinary, team science approaches to achieving a predictive understanding of how complex traits of an organism emerge from the interaction of its genetic makeup with the environment. URoL science advances biological theory that explains the complexity, diversity, and adaptability of living systems. BIO also will continue foundational investments that support the goals of URoL through its institute-scale program, Biology Integration Institutes, and its Integrative Biology program, which promotes ambitious, high-risk/high-reward collaborative research. A priority within these funding programs is discovery of rules of life and advancing understanding of functional genomics, especially plant genomics, that can inform applications in agriculture, energy, and climate change mitigation.

BIO Funding for Centers Programs and Major Facilities

BIO Funding for Centers Programs

(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over	
				FY 2021 Actual Amount	Percent
Biology Integration Institutes	\$19.95	-	\$49.50	\$29.55	148.1%
Centers for Analysis & Synthesis	-	-	5.00	5.00	N/A
STC: Biology with X-ray Lasers	4.15	-	-	-4.15	-100.0%
STC: Center for Cellular Construction	5.20	-	5.00	-0.20	-3.8%
STC: Center for Research on Programmable Plant System	-	-	5.00	5.00	N/A
Total	\$29.30	-	\$64.50	\$35.20	120.1%

BIO supports investment in core research and education as well as research infrastructure. In FY 2023, BIO will invest \$64.50 million in research centers, accounting for 6.8 percent of the BIO budget, funding twenty BIs, two Centers for Analysis and Synthesis, and two Science and Technology Centers. O&M funding for BIO-supported facilities is 7.4 percent of BIO's FY 2023 Request.

For detailed information on individual centers programs, please see the Cross Theme Topics section of the NSF-Wide Investments chapter.

BIO Funding for Major Facilities

(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over	
				FY 2021 Actual Amount	Percent
National Ecological Observatory Network (DBI)	\$65.00	-	\$70.00	\$5.00	7.7%

For detailed information on individual facilities, please see the Research Infrastructure section of the NSF-Wide Investments chapter.

Funding Profile

BIO Funding Profile			
	FY 2021		
	Actual	FY 2022	FY 2023
	Estimate	(TBD)	Estimate
Statistics for Competitive Awards:			
Number of Proposals	3,960	-	4,000
Number of New Awards	1,175	-	1,200
Regular Appropriation	1,175		1,200
ARP			
Funding Rate	30%	-	30%
Statistics for Research Grants:			
Number of Research Grant Proposals	3,355	-	3,400
Number of Research Grants	934	-	1,000
Regular Appropriation	934		1,000
ARP			
Funding Rate	28%	-	29%
Median Annualized Award Size	\$222,366	-	\$230,000
Average Annualized Award Size	\$260,029	-	\$270,000
Average Award Duration, in years	3.5	-	3.5

People Involved in BIO Activities

Number of People Involved in BIO Activities				
	FY 2021	FY 2021		
	Actual	ARP Actual	FY 2022	FY 2023
	Estimate	Estimate	(TBD)	Estimate
Senior Researchers	4,474	-	-	5,000
Other Professionals	1,402	-	-	1,600
Postdoctoral Associates	1,638	135	-	1,700
Graduate Students	2,926	-	-	3,800
Undergraduate Students	4,225	-	-	4,700
K-12 Teachers	-	-	-	-
K-12 Students	-	-	-	-
Total Number of People	14,665	135	-	16,800

DIVISION OF BIOLOGICAL INFRASTRUCTURE (DBI)

\$221,280,000
+\$54,270,000 / 32.5%

DBI Funding
(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	FY 2021 Actual Amount	Actual Percent
Total	\$167.01	-	\$221.28	\$54.27	32.5%
Research	28.98	-	77.17	48.19	166.3%
Centers Funding (total)	9.15	-	50.00	40.85	446.4%
Biology Integration Institutes	-	-	37.00	37.00	N/A
Centers for Analysis & Synthesis	-	-	3.00	3.00	N/A
STC: Biology with X-ray Lasers (BioXFEL)	4.15	-	-	-4.15	-100.0%
STC: Center for Cellular Construction (CCC)	5.00	-	5.00	-	-
STC: Center for Res. on Program. Plant Sys. (CROPPS)	-	-	5.00	5.00	N/A
Education	20.89	-	31.00	10.11	48.4%
Infrastructure	117.14	-	113.11	-4.03	-3.4%
MSRIAP	0.50	-	-	-0.50	-100.0%
NEON	65.00	-	70.00	5.00	7.7%
NNCI	0.35	-	0.35	-	-
Research Resources	51.29	-	42.76	-8.53	-16.6%

About DBI

DBI empowers biological discovery by investing in the innovation and capacity-building of cutting-edge research infrastructure for fundamental biological science, which includes human capital, technologies, institutes and centers, and mid-to-large scale infrastructure. DBI supports the development of, and improvements to, research infrastructure, including cyberinfrastructure; bioinformatics; biotechnology; instrumentation; and improvements to biological research collections, living stock collections, and field stations and marine labs. In addition, DBI supports the development of human capital at the undergraduate level by participating in the NSF-wide IUSE program, and the Research Experiences for Undergraduate Sites program. DBI also offers a multi-track postdoctoral research fellowships program with special emphasis on interdisciplinary research training, and on broadening participation in the biological sciences.

In calendar year 2021, BIO launched several new programs that have a strong emphasis on broadening participation at the individual or institutional level and are managed through the Human Resources cluster of DBI. DBI also provides sustained support for key facilities and other resources that enable researchers across the full breadth of biology to address targeted but deep questions. DBI supports the operation and maintenance of NEON, which is enabling study of the biosphere and its response to environmental change at a continental scale. NEON goals have major societal impact, particularly with respect to ecological forecasting. Additional infrastructure support will focus on developing the capacity of the biological sciences research community through funding cyberinfrastructure and other tools necessary to address the NSF URoL Big Idea.

In general, about 27 percent of the DBI portfolio is available for new research grants. The remaining 73 percent supports research grants made in prior years and the research infrastructure needed by the biological sciences community.

DIVISION OF ENVIRONMENTAL BIOLOGY (DEB)

\$186,150,000
+\$7,370,000 / 4.1%

DEB Funding
 (Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	FY 2021 Actual	
				Amount	Percent
Total	\$178.78	-	\$186.15	\$7.37	4.1%
Research	174.87	-	183.65	8.78	5.0%
Education	3.91	-	2.50	-1.41	-36.1%

About DEB

DEB supports fundamental research on Earth’s biodiversity and the ecological and evolutionary processes that explain the origin and maintenance of genetic variation in living systems, including its history and patterns of speciation and extinction. DEB also supports research that advances understanding of the important role biodiversity plays in regulating ecological and ecosystem processes over both short- and long-temporal scales and varying spatial scales. The discoveries from this research can inform strategies to develop, utilize, and sustain biological resources, including natural, agricultural, and other managed ecosystems, and to forecast changes in species populations and ecosystems responding to climate change and other anthropogenic disturbances.

In addition to disciplinary programs in ecology, evolution, and biodiversity, DEB provides support for long term ecological research (LTER), and for research addressing continental-scale questions in macrosystem biology. DEB programs encourage the use of data samples and other resources provided by the National Ecological Observatory Network (NEON) and other NSF infrastructure investments. DEB funded research provides the data, knowledge, and capability to advance models that can predict the spread of infectious diseases and invasive species, and their impacts on wild, managed, and agricultural systems. Eco-forecasting models developed from biodiversity and ecological research are also used to predict environmental drivers of conflict, enhance our ability to strategically prepare for environmental threats, and field defense and mitigation capabilities that are resilient and adaptive.

In general, about 75 percent of the DEB portfolio is available for new research grants, and 25 percent is available for continuing grants.

DIVISION OF INTEGRATIVE ORGANISMAL SYSTEMS (IOS)

\$214,810,000
+\$7,920,000 / 3.8%

IOS Funding
(Dollars in Millions)

	FY 2021 Actual	FY 2022 (TBD)	FY 2023 Request	Change over	
				FY 2021 Actual Amount	Actual Percent
Total	\$206.89	-	\$214.81	\$7.92	3.8%
Research	187.73	-	199.01	11.28	6.0%
Education	7.74	-	4.80	-2.94	-38.0%
Infrastructure	11.42	-	11.00	-0.42	-3.7%
Research Resources	11.42	-	11.00	-0.42	-3.7%

About IOS

IOS supports fundamental research and training focused on mechanistic analyses of the functional phenotypic characteristics of diverse organisms. IOS prioritizes integrative research linking biological molecules to complex populations through understanding the processes that build and maintain diverse organisms in the contexts in which they function. Spanning the gamut of biological diversity, including viruses and other microbes, fungi, and wild and domesticated plants and animals, IOS-funded research reveals the mechanisms underlying multi-scale emergent properties of organisms that allow them to function as they do in a variety of developmental, social, physiological, and environmental contexts. Specifically, IOS-funded research uncovers how the nervous system, organismal growth and development, behavioral, genetic, genomic, biochemical, biophysical, and physiological processes are integrated and result in the stability and flexibility of organisms living in dynamic environments. Such analyses are essential to understanding the principles that produce the vast diversity of life on Earth and the mechanisms that allow for biological resilience and adaptation to change.

IOS encourages interdisciplinary science, and the development of new approaches, to solve basic and applied problems through the Enabling Discovery through Genomics and Organismal Response to Climate Change Programs. IOS continues to leverage its activities across the spectrum of NSF basic science, together with agricultural research supported by the U.S. Department of Agriculture's National Institutes of Food and Agriculture, by supporting research on plant biotic interactions, genomics, and innovative tools for high-throughput analysis of agriculturally important plants. IOS prioritizes investments in computational biology in neuroscience and support for the NSF-Simons Research Centers for Mathematics of Complex Biological Systems.

Results of IOS-supported research contribute to the URoL and other NSF Big Ideas. IOS-supported science is highly relevant to the bioeconomy and societal needs for pandemic preparedness, food security and sustainability, understanding the healthy brain, and understanding how organisms respond, withstand, and adapt to multi-dimensional stressors, including those associated with life in a changing world.

In general, about 66 percent of the IOS portfolio is available for new research grants, and 34 percent is available for continuing grants.

DIVISION OF MOLECULAR AND CELLULAR BIOSCIENCES (MCB) **\$162,470,000**
+\$6,920,000 / 4.4%

MCB Funding (Dollars in Millions)					
	FY 2021	FY 2022	FY 2023	Change over	
	Actual	(TBD)	Request	FY 2021 Actual Amount	Percent
Total	\$155.55	-	\$162.47	\$6.92	4.4%
Research	153.36	-	159.47	6.11	4.0%
STC: Center for Cellular Construction (CCC)	0.20	-	-	-0.20	-100.0%
Education	0.94	-	2.00	1.06	112.8%
Infrastructure	1.25	-	1.00	-0.25	-20.0%
Facilities Design Stage Activities (total)	1.25	-	1.00	-0.25	-20.0%
Center for High Energy X-ray Sciences (CHEXS)	1.25	-	1.00	-0.25	-20.0%

About MCB

MCB supports fundamental interdisciplinary research to uncover the basic principles that describe cellular function at the molecular level, including (a) how information content in cells is maintained and transmitted to the next generation and guides expression of cellular characteristics; (b) how material and energy are absorbed, transformed, and flow through biological systems; and (c) how biological molecules assemble into complex structures and compartments with varied functions. MCB also supports research that uses molecular biophysics, systems biology, and synthetic biology to probe fundamental biological questions that address the essential processes required for life. Due to its interdisciplinary nature, MCB research contributes to NSF's Big Ideas, URoL, and QIS-related activities.

Additionally, MCB supports convergence research at both molecular and cellular scales. This basic research at the interface of biological, mathematical, physical, and computer sciences and engineering provides the basis for a quantitative, predictive, theory-driven understanding of molecular and cellular functions of biological systems across the tree of life. MCB supported research continues to leverage the latest advances across science and engineering, including single molecule imaging, artificial intelligence, and synthetic biology, while also advancing a clear mechanistic understanding of biological processes such as deoxyribonucleic acid (DNA) maintenance and repair, clustered regularly interspaced short palindromic repeats (CRISPR), and CRISPR-associated (Cas) genome editing. Advances in fundamental research not only enable the development of design rules for engineering molecules and cells, but also directly contribute to biological innovations that advance emerging industries and the U.S. bioeconomy, medicine, agriculture, environmental sustainability, and biomanufacturing sectors. MCB research has the potential to address future challenges by providing biotechnology solutions to mitigate the impact of climate change; predicting, detecting, and preventing future pandemics; and ensuring food production on a changing planet.

In general, about 80 percent of the MCB portfolio is available to support new research grants, and 20 percent is available for continuing grants.

DIVISION OF EMERGING FRONTIERS (EF)

\$185,520,000
+\$76,010,000 / 69.4%

EF Funding
(Dollars in Millions)

	FY 2021	FY 2022	FY 2023	Change over	
	Actual	(TBD)	Request	Amount	Percent
Total	\$109.51	-	\$185.52	\$76.01	69.4%
Research	105.65	-	117.52	11.87	11.2%
Centers Funding (total)	19.95	-	14.50	-5.45	-27.3%
Biology Integration Institutes	19.95	-	12.50	-7.45	-37.3%
Centers for Analysis & Synthesis	-	-	2.00	2.00	N/A
Education	3.68	-	68.00	64.32	1747.8%
Infrastructure	0.18	-	-	-0.18	-100.0%
Research Resources	0.18	-	-	-0.18	-100.0%

About EF

EF serves as an incubator for innovation and integration within the biological sciences. It supports research that transcends scientific disciplines and advances conceptual foundations across all levels of biological organization. Innovative research and infrastructure activities in BIO typically begin development in EF and then move to other BIO divisions to become part of the disciplinary knowledge base. For example, support for design and early construction of NEON originated within EF but moved to DBI once NEON operations were initiated. EF also facilitates the development and implementation of new forms of merit review and mechanisms to support transformative research and stimulate creativity.

EF provides the support for BIO participation in national initiatives, NSF priority areas, and other interdisciplinary, cross-division, and cross-directorate programs. Hence, EF is the steward for investments in NSF’s URoL Big Idea. In addition, EF will support innovative research and training that integrates across scales of biology, contributes to a re-unification of biology, and supports U.S. global competitiveness in the bioeconomy.

In general, about 50 percent of the EF portfolio is available for new research grants. The remaining 50 percent supports research grants made in prior years and research infrastructure needed by the biological sciences community.